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DETERMINATION OF THE ENVIRONMENTAL FATE OF GROUND SQUIRREL CARCASSES

By

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ABSTRACT

A field study was conducted in Lewis and Clark County, Montana during the summer of 1986 to determine the fate of Columbian ground squirrel carcasses in the environment. Ground squirrel carcasses were marked with radio transmitters and placed in situations and locations simulating those found in actual rodent control operations. Carcasses were monitored until their fate was determined or were no longer considered attractive to scavengers. Fox, the primary scavenger in this study, skunk and birds (corvids and/or raptors) were the mammalian and avian scavengers identified. Carrion-eating insects quickly attacked the carcasses and were important in determining the maximum exposure time of the carcasses to scavengers. Factors determining the risks to scavengers from rodent control operations are discussed.

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INTRODUCTION

Field rodents, such as ground squirrels that damage agricultural crops, are frequently controlled using various rodenticide baits. After rodenticide treatment of a field rodent population, it is not uncommon to find rodent carcasses killed by the rodenticide on the ground surface in the treatment area. Because the carcasses may contain some quantity of the rodenticide, which may present a hazard to animals scavenging on the carcasses, the fate and degradation time of the carcasses in the environment is of interest.

OBJECTIVE

The study objective was to determine the fate and degradation time of ground squirrel carcasses in the environment. The objective was accomplished by placing marked ground squirrel carcasses in field conditions that simulated carcass density and location likely to occur following a normal rodent control program. The carcasses were monitored until their fate was determined or they decomposed to a point where they were no longer believed to be attractive to scavengers.

STUDY AREA

Two study sites were selected from agricultural land in Lewis and Clark County, Montana. Each site was occupied by Columbian ground squirrels (*Spermophilus columbianus*) and represented areas where rodent control is a usual practice. Both study areas were dryland pastures and noncrop areas bordering crops of alfalfa and small grain. The study areas were two miles apart.

The general area surrounding the study site is regarded as rural although a suburban subdivision, an industrial park and a major airport facility occur within a three mile radius of the study areas. The major agricultural crops in the area are alfalfa hay, pastures and small grains. The main canal of the area irrigation system passes adjacent to both study sites. A stream bordered by decidous trees and shrubs runs within two miles of each site.

METHODS

Columbian ground squirrels were live trapped from the wild and killed using CO_2 gas. Each squirrel was weighed, sexed and toe-clipped for individual identification. After death, squirrel carcasses were handled using surgical gloves and stored individually in polyethylene bags to minimize contamination by foreign odors. Squirrel carcasses placed in the field within one or two days after death were stored under refrigeration. Squirrel carcasses held for a longer period of time were frozen.

Frozen carcasses were thawed under refrigeration before they were placed in the field.

Each carcass was fitted with a radio transmitter. Each transmitter was set to a different frequency allowing identification of individual squirrel carcasses. In addition to a standard collar attachment, the transmitter collars were secured to the skeleton by passing a nylon tie through the carcass around the pectoral girdle.

Ground squirrel carcasses were placed on each study site at a density of approximately four carcasses per acre in active squirrel colonies. This density is similar to the carcass density observed by Sullivan (1982) and Baril and Sullivan (1983) using bait stations containing anticoagulants in similar situations. Twenty squirrel carcasses were placed on each site. Five carcasses per day for four consecutive days were placed on each study site.

Carcasses were placed on the study sites in equal numbers in each of four situations. These situations were based on locations of squirrel carcasses found after actual rodent control operations (Sullivan 1982, Baril and Sullivan 1983).

L1. Burrow opening - 0% cover
L2. Open ground - 0 - 25% cover
L3. Open ground - 25% - 50% cover
L4. Open ground - >50% cover

Carcasses were monitored once per day. Observations continued until the carcasses were consumed by scavengers or were completely degraded by insects.

When possible, identification of avian and mammalian scavengers was determined by the use of field sign (tracks, scat), carcass remains which indicated feeding behavior typical of certain scavengers, association of carcasses or transmitters with den areas, and knowledge and observation of potential scavengers in the area. Carrion-eating insects found on the carcasses were collected and identified.

Weather information, including daily minimum and maximum ambient temperatures and daily precipitation, was recorded during the study period.

Control carcasses, caged and fenced to prevent access by avian and mammalian scavengers while allowing access by insect fauna, were used to determine carcass degradation times when not disturbed by larger scavengers. Carcasses were observed for nine days. Carcass weight and condition were recorded daily.

This study was conducted on one site during the first two weeks of June, 1986 just following emergence of the young-of-the-year from their natal burrows. It was repeated on the second site during the first two weeks of August, 1986 just before the

beginning of estivation by the squirrels. Both periods are times when control programs for the Columbian ground squirrel are often conducted in Montana.

RESULTS

Fox (Vulpes fulva) were the major scavengers identified in this study and are believed to have consumed at least 14 carcasses. Unknown scavengers consumed 11 carcasses. Field observations indicated fox or skunk (Memphitis memphitis) as the likely scavengers involved. Four carcasses were scavenged by birds (corvids or raptors). Carrion-eating insects were responsible for the degradation of eight carcasses and had begun degradation of most of the other carcasses prior to consumption by avian or mammalian predators. The transmitter signals from three carcasses were not received when the carcasses were initially moved and their fate is unknown (Table 1).

Carcass longevity after placement on the study sites ranged from one to eight days. The average longevity, excluding carcasses degraded by insects alone, was three days (Table 1). The number of carcasses taken by scavengers or degraded by insects for each successive day postplacement is shown in Table 2.

Table 3 shows the longevity of carcasses by placement location. No obvious trend is seen when study sites are looked at separately. When Sites 1 and 2 are combined the data indicate there is little or no difference in carcass longevity that is related to the visibility of the carcasses.

Carrion-eating insects determined the maximum degradation time if carcasses were undisturbed by larger scavengers (Table 1). Flies located the carcasses within the first day after placement on the study sites. It was not unusual to observe flies on and around the carcass immediately after the carcass was placed on the ground. Fly egg masses were found on most carcasses by the end of two days. By Day 4, carcass weight decreased by an average of 24 percent and fly larvae represented 25-50 percent of the total carcass weight. At Day 6 most of the viscera and muscle tissue had been consumed by the fly larvae. The carcass was largely a shell of skin and bone providing shelter for the larvae. By Day 7 most fly larvae had disappeared from the carcass. The remaining carcass, sometimes appearing little changed from its original appearance, continued to desiccate to 10-15 percent of its starting weight (Table 4, Figure 1). Various species of beetles and ants were also attracted to the carcasses but probably contributed only a small part to the carcass degradation. The carrion-eating insects observed in this study included Blow Flies (Calliphoridae), Flesh Flies (Sarcophagidae), Carrion Beetles (Silphidae), Rove Beetles (Staphylinidae), Dung Beetles (Scarabaeidae), and Harvester Ants (Formicidae).

TABLE 1. Placement location, carcass longevity and carcass fate.

Carcass No.	Site 1 (June) Loc*	Days**	Fate	Site 2 (August) Loc*	Days**	Fate
1	L4	3	Unk(fox/skunk?)	L1	1	Unk(skunk?)
2	L3	3	Unk(fox/skunk?) found in burrow	L3	6	Insect
3	L1	4	Unk(fox/skunk?)	L2	7	Insect
4	L2	1	Fox(den area)	L4	5	Unk(skunk?)
5	L1	8	Insect	L1	6	Insect
6	L2	2	Fox(den area)	L2	5	Fox(den area)
7	L4	4	Fox(den area)	L3	2	Unk(skunk?)
8	L4	4	Lost	L1	1	Lost
9	L1	2	Lost	L4	5	Fox(den area)
10	L3	3	Fox(den area)	L2	4	Fox(den area)
11	L2	1	Unk(fox/skunk?)	L3	3	Fox(den area)
12	L1	2	Fox(den area)	L4	3	Unk(skunk?)
13	L2	2	Fox(den area)	L1	2	Unk(skunk?) found in burrow
14	L1	5	Fox(den area)	L3	2	Unk(skunk?) found in burrow
15	L4	3	Fox(den area)	L4	2	Birds
16	L4	3	Fox(den area)	L1	4	Birds
17	L3	4	Birds	L2	5	Insect
18	L2	6	Birds	L4	5	Insect
19	L3	2	Unk(fox/skunk?)	L4	5	Insect
20	L3	4	Fox	L2	5	Insect
		Ave*** 3.05			Ave*** 3.00	

* Loc: Carcass Placement Location. L1-burrow opening; L2- above ground 0-25% cover; L3-above ground 25-50% cover; L4-above ground >50% cover

** Days: Carcass Longevity post placement on study site.

*** Ave: Average carcass longevity for carcasses other than those degraded only by insects.

Table 2. Carcass longevity by day, post placement.

	Site 1	Site 2	Site 1 & 2
Carcass Longevity In Days	No. of Carcasses	No. of Carcasses	No. of Carcasses
1	2 (10%)	2 (10%)	4 (10%)
2	5 (25%)	4 (20%)	9 (22.5%)
3	5 (25%)	2 (10%)	7 (17.5%)
4	5 (25%)	2 (10%)	7 (17.5%)
5	1 (5%)	6 (30%)	7 (17.5%)
>5	2 (10%)	4 (20%)	6 (15%)

Table 3. Carcass longevity by placement location.

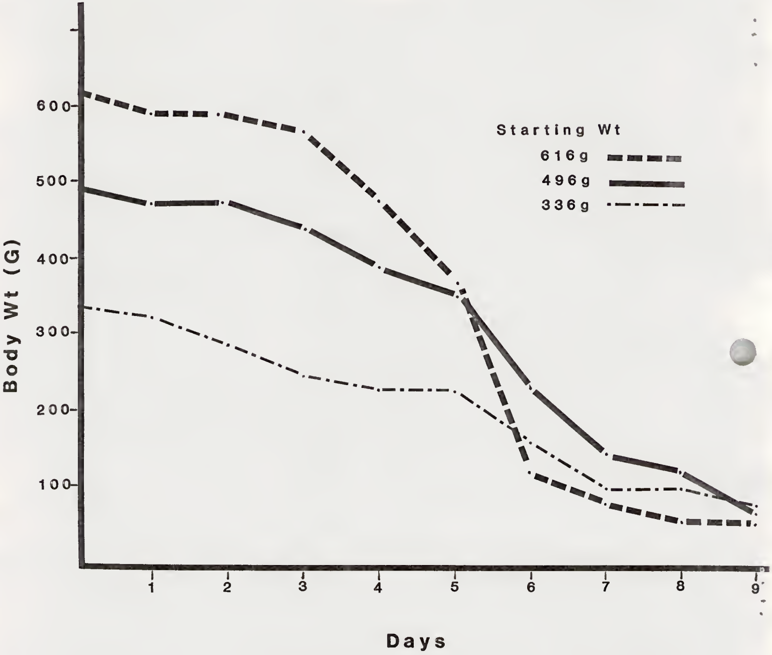
	Site 1						Site 2						Site 1 & 2
	Days					Ave	Days					Ave	Ave
L1 Burrow Opening	4	(8)	2	2	5	4.20	1	(6)	1	2	4	2.33	3.50
L2 0-25% Cover	1	2	1	2	6	2.40	(7)	5	4	(5)	(5)	5.20	3.80
L3 25-50% Cover	3	3	4	1	4	3.20	(6)	2	3	3	(7)	4.00	3.60
L4 >50% Cover	3	4	4	3	3	3.40	(5)	5	3	2	(5)	4.00	3.70

( ) - carcasses degraded by insects alone

Table 4. Generalized degradation of ground squirrel carcasses by carrion-eating insects.

Days Post Carcass Placement	Ave % Weight Loss	Carcass Condition
0	0	Flies present on and around carcass.
1	3.7%	Carcass not noticeably changed. Flies present. Usually no obvious egg masses.
2	6.1%	Little change in overall appearance, eyes may be sunken and abdomen bloated. Slight odor may be present. Fly egg masses present. Occasionally small fly larvae are found. Ants and beetles present.
3	13.0%	Carcass odor obvious. Flies abundant, increasing number and variety of beetles. Numerous fly egg masses and small larvae
4	24.0%	Strong odor. Eyes and abdomen sunken. Hair may begin sloughing from some carcasses. Fly larvae throughout viscera and moving into muscle tissue. Fly larvae represent 25-50% of carcass weight. Numerous beetles. Ants feeding on larvae
5	34.4%	Similar to Day 4 but fly larvae represent the majority of body weight and are found throughout the muscle tissue.
6	64.8%	Large numbers of fly larvae may still be present but carcass is usually a shell of drying skin and bones.
7	77.6%	Most larvae are gone although portions of carcass may still be occupied(cecum,skull&neck) Beetles/ants present, a few adult flies are seen.
8	81.0%	Carcass continues to desiccate
9	85.8%	Desiccation continues, carcass is a shell of skin and bones.

Figure 1. Daily weight loss of ground squirrel carcasses caged from scavengers but allowing access by insect fauna.



DISCUSSION

The fate of carcasses is dependent on the scavenger fauna present at the site where rodent control is conducted. The species present and the relative proportions of each will be different at each site depending on the habitat and geographic location. In this study terrestrial predators (fox and skunk) were the dominant scavengers. In areas where these animals are not common or are not present, fate of carcasses can be expected to be different.

The importance of carrion-eating insects in carcass degradation cannot be underestimated. They determine the maximum exposure time of carcasses to scavengers. In this study the maximum exposure time was about one week. Because of the flies' ability to locate and consume the carcass so rapidly and the likely metabolism and degradation of rodenticide residues by action of the larvae, the actual exposure time when risk to the scavengers is highest is probably limited to the first three or four days.

Degree of risk to nontarget scavengers in an actual rodent control program is dependent on several factors:

1. Availability of carcasses (i.e. the number of animals dying above ground).
2. The rodenticide used (relative toxicity, acute vs multidose).
3. The ability of the target rodent to detoxify the rodenticide before death.
4. Rate and method of rodenticide applications which determines the carcass residue load.
5. Sensitivity of each nontarget species to the rodenticide used.
6. The ability of the scavenger to locate carcasses, particularly immediately after death.
7. The rate of rodenticide degradation in the carcass.
8. Carcass longevity.

Full knowledge by the rodenticide user of these risk factors, which is different for each rodenticide, is important in assessing and reducing nontarget risks.

With the current state of rodent control methods and materials available to agricultural producers, risk of nontarget death resulting from rodent control operations will occur. Clearly, the foxes scavenging on squirrel carcasses in this study would have been at risk if the carcasses had contained residues of some of the commonly used rodenticides. This study indicates that management of depredating rodent populations is not limited to prevention of rodent damage by use of rodenticides or other methods, but also concerns management of risks to nontarget populations as well.

There is a need to control rodent populations that damage agricultural crops. Because rodenticides are both effective and economical, they will continue to be the primary control method

in the foreseeable future, especially on larger crop acreages. The question is not whether nontarget mortality will occur with current rodent control technology, but whether risks to nontarget populations can be managed within acceptable limits. With full knowledge of the nontarget risk factors and implementation of sound rodent management practices and precautions for nontarget safety, impact to nontarget populations can be kept within these limits.

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Appendix 1. Daily weather data.

Site 1				Site 2			
	Temperature (^{O}F)				Temperature (^{O}F)		
Date	Min.	Max	Precip(in.)	Date	Min.	Max.	Precip(in)
6-2-86	46	91	0	8-1-86	50	84	0
6-3-86	44	82	0.05	8-2-86	48	87	0
6-4-86	54	82	0.40	8-3-86	53	88	0
6-5-86	55	78	0.10	8-4-86	50	85	T
6-6-86	53	79	0	8-5-86	47	82	0
6-7-86	55	81	0	8-6-86	49	87	0
6-8-86	46	70	0.15	8-7-86	47	92	0
6-9-86	48	82	0	8-8-86	50	88	0
6-10-86	46	88	0	8-9-86	50	94	0
6-11-86	49	88	0	8-10-86	47	78	0
	Ave 49.6	Ave 81.5	Total 0.70		Ave 49.1	Ave 86.5	Total T